AFFORDABLE SMART HEXAPODS FOR STEM EDUCATION

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BACKGROUND

What is a Hexapod?

A hexapod is robot that has six legs. Unlike robots with wheels or tracks, hexapods can use their legs to traverse unstructured terrain. The CSIRO have dedicated a significant amount of research towards the design of hexapod robots. Their smallest and most affordable hexapod to date is Zero (shown right), which runs off a Raspberry Pi computer, 18 Dynamixel servo motors, a Pi Cam and is remote controllable.

Problem

The goal of this project was to enhance the autonomous capability of Zero to improve its suitability as a platform for teaching STEM education.

Scope

Autonomous capability was added to Zero by designing and integrating a new sensor. The aim of the sensor was for it to be retrofittable, modular, inexpensive and plug & play. Autonomous algorithms such as obstacle avoidance were also developed to showcase the capability of the new sensor.

DESIGN

The VSM Sensor Module

The VL53L1X is a miniature time of flight distance sensor by STMicroelectronics that was used as the basis for the new modular sensors. It offers 4 metre ranging distances, 50 Hz measurement frequencies and an adjustable field of view. A custom printed circuit board known as the VSM (show below) was designed to house this sensor and provide modular, plug & play capability.





The VSM360 Sensor

Full 360 degree sensing coverage was achieved on Zero by daisy-chaining 12 VSMs in a ring configuration. The sensor modification can be seen on the top portion of Zero.

VSM Drivers

Special libraries were created to simplify use of VSM sensors on Arduino, Raspberry Pi and Jetson Nano. The libraries extend the VL53L1X manufacturer drivers by simplifying the setup required for running multiple VSMs.

INTEGRATION

VSM ROS Node

Robot Operating System, or ROS, is a free, open source framework designed for modern robotics. A ROS node was created to simplify use of VSM sensors in ROS environments. The node publishes sensor distance data to a topic that other nodes can subscribe to and process.

Potential Field Algorithm

Has anyone ever invaded your personal space? Zero doesn't like people in its personal space either. When a person or obstacle gets too close to Zero, it sees a

high amount of potential in that direction. Zero actively avoids obstacles by heading towards low potential. This was achieved by creating another ROS node that converts sensor distance data into a potential field (visualised below).



Spikes in the potential plot correspond to obstacles in the real world. When there are no obstacles, the potential plot has a 'U' shape that naturally guides Zero forward. The VSM sensors and potential field algorithm were able to successfully provide Zero with fully autonomous navigation and obstacle avoidance.



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